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Who can you trust? Implications of institutional vulnerability in flood exposure along the Spanish Mediterranean coast

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ABSTRACT

Over the last years, the Spanish Mediterranean coastal area has undergone significant increase in the number of floods and their consequential damages. However, according to climatic records, this trend is more related to an exposure multiplication than with the increase of extreme rainfall events. Within this framework, it is interesting to evaluate how the different local governments have influenced on urban growth in flood-prone areas through a deficient spatial planning, also to evaluate its possible relation with sociodemographic factors. The proposed methodology is based on two institutional vulnerability index related to the local spatial planning intersection with the hydrological modelling data, and a multiple linear regression of these index value and several socio-demographic parameters (population, tourists, housings, etc…). The final results demonstrate how local governments increase exposure and its relationship to population growth, foreign tourist and economic causes.

1. Introduction

Recent decades have seen an increase in the intensity, frequency and economic losses related to floods in Europe (Barredo, 2007; Marchi et al., 2010). This situation has been accentuated in the Mediterranean region (Jonkman, 2005), especially in Spain and Italy (Llasat et al., 2010). In fact, in Spain floods are the natural hazard with the greatest territorial impact (480,000 ha are high probability floodable areas, SNCZI, 2015) and are responsible for great socio-economic losses (3400 million euros and 311 human deaths between 1995 and 2014, CCS, 2014).

Some authors have suggested that the increase in the impact of floods is due more to socio-economic factors than to climate-related factors (Barredo et al., 2012; IPCC, 2012; Pérez et al., 2015a). In this context, the social factor involved in the risk equation established by Wisner et al. (2004), vulnerability, is particularly relevant with respect to changes in the flood risk, but is very difficult to measure because social and environmental issues are at stake (Gil-Guirado et al., 2016). Despite there are a multitude of definitions of vulnerability (e.g. Calvo, 2001; Wisner et al., 2004; Parker et al., 2009), we understand vulnerability "as the capacity of a society to deal with hazard" (IPPC, 2012). This meaning that vulnerability is an exclusively social concept (Fuchs, 2009) whose value is determined by a series of social factors (e.g. economy, politics, education, etc.), that vary considerably depending on the author (Appendix A). Among different vulnerability factors are a series of synergistic or antagonistic relationships, whose weighted consideration represent the final value of vulnerability (Wilches-Chaux, 1993).

Given the difficulty of knowing to what extent each of the vulnerability factors influence final vulnerability (Calvo, 2001), a successful way of approaching their study is through the detailed analysis of each one. In this respect, there is no doubt concerning the role played by the different administrations responsible for guiding the capacity of adaptation to the environment hazards. Despite the main task of the different administrations is to limit the exposure of citizens to hazards (Giddens, 2002), there are some regions in where this situation is far from being the case (e.g. Thailand, Lebel et al., 2011; USA, Burby, 2006; the Netherlands, Jongman et al., 2014).

By the way of example, the works of Fuchs et al. (2015, 2017) demonstrated how the current exposure level in the European Alps (Austria and Switzerland) does not depends exclusively on the environmental factor, because is also related to the economic activities and the different weaknesses of the established measures (structural and non-structural). Likewise, Pérez et al. (2015a) showed that, the increase of flood exposure in the Spanish Mediterranean coast, is positively correlated with periods of economic growth and legal permissiveness. According to this, we have to consider vulnerability as cause able to determine exposure (e.g. Adger, 2006; Parker et al., 2009; Wisner et al., 2004), instead of two independent values (e.g. Cardona et al., 2012; Smith and Petley, 2009).

This vulnerability factor is called institutional vulnerability (hereinafter IV) (Raschky, 2008; Parker et al., 2009; Fuchs, 2009) and

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represents the sensitivity of public administrations to deal with hazards (Parker et al., 2009). Although from an economic point of view, organizations and institution are two facets of one and the same phenomenon (Commons, 1934), we understand institutions as "systems of established and prevalent social rules that structure social interactions" (Hodgson, 2006). However, organizations are a special kind of institution made up of groups of individuals bound together by some common purpose to achieve certain objectives, i.e. while institutions are the rules of the game the organizations are the players (North, 1994). In this regard, we define IV as "the inefficiency of the different authorities responsible for hazard management whose results imply an exposure increase on societies, i.e. amplifies hazard". The IV involves institutions and organizations in charge of hazard management (e.g. governments, civil protection, warning systems, spatial planning) or related to it (e.g. risk communication, NGO's, healthcare systems, education, research centres). IV is influenced by other vulnerability factors (Wilches-Chaux, 1993) and by several internal limitations (e.g. technical, legislative, staff) and external pressures (e.g. political, social, employment) where corruption is its greatest weakness (Wisner, 2000).

Although there is no universally accepted methodology used by administrations to limit the risk of flooding, there is no doubt that spatial planning (SP) has a preventive role to play as non-structural measure of impact mitigation (Directive 2007/60/CE; Olcina, 2010b; Cardona et al., 2012). In this way, SP is a tool able to decrease the exposure to floodable areas to obtain a balanced development between the inhabitants and the managed space (Adger, 2006; Birkmann, 2006). In this sense, SP is more efficient than structural measures, because prevents the floodable areas occupation since the beginning and avoids the false sense of safety generated by technical means (Lane et al., 2011). However, despite the high degree of efficiency to mitigate the risk of flooding that SP is supposed to involve (Fleischhauer, 2006), SP has several limitations (Smith and Petley, 2009; Fuchs et al., 2015 Fuchs et al., 2015) and is affected by a series of obstacles that hinder its correct application (Sutanta et al., 2010). In this regard, in geographical areas such as the Spanish Mediterranean coast, huge economic incentives arising from land speculation have become an important vulnerability factor (Smith and Petley, 2009) that hinders the implementation of flood damage mitigation measures (Iglesias, 2007; Romero et al., 2012).

The Spanish Mediterranean coastal area is one of the main tourist destinations in the world (WTO, 2016). More than 6 million people normally reside in this area and millions of tourists annually visit it (Boniface et al., 2006). This social dynamic, generated by "Sun and beach" tourism, has caused a tourist "boom" that multiplied the amount of buildings by six in only ten years (Sánchez, 2008). This concentration of people and buildings is related to a deficient SP which have not consider flood-prone areas and the adoption of engineering solutions as main flood risk management (FRM) (Pérez et al., 2015a; Saurí et al., 2001). As a consequence, this process has resulted in the so-called "coastalisation of risk" (Olcina, 2009).

Thus, the objectives of this study are to: 1) quantify the IV to flood hazards 2) analyse and quantify the explanatory factors flooding exposure and 3) identify black spots where actual and potential IV levels compromise population security. To conduct the study, we selected as study area the municipalities of the Spanish Mediterranean coast, due to its great socio-economic importance and for being one of the areas most affected by floods in Europe (Schmidt-Thomé, 2006).

2. Study area and legal framework

The methodology was applied to all the Spanish Mediterranean coastal municipalities, from Águilas (Murcia) to Portbou (Girona) (Fig. 1). The study area covers 8358 km^2 administratively divided into 137 municipalities, seven provinces (Alicante, Barcelona, Castellón, Gerona, Murcia, Tarragona and Valencia) and three autonomous communities (Catalonia, Comunidad Valenciana, and Región de Murcia). Currently this area has 6,312,997 inhabitants, 14% population of Spain (INE, 2015), that since the mid XX century has suffered a large influx of immigration from the interior of Spain. However the highest rates of population growth and real estate was recorded between 2000 and 2011 (INE, 2015), due to the arrival of many foreigners (the percentage of foreing population increased from 5.31% to 15.20%).

From an hidrologyc point of view, the area has an irregular distribution of the size of the drainage basins where, with the exception of the large rivers present in the study area (Ebro, Júcar and Segura), the most common are ephemeral rivers (ramblas) responsible of flash floods after an intense rainfall (typical of the Mediterranean climate). However, this small water courses has had little social importance (Saurí et al., 2001).

In Spain, despite the different spatial planning legislations (from the firs Land Law of 1956 to the currently in force Land Law of 2008) have gradually incorporated natural risk analysis, there is a lack of any state law framework concerning natural hazards. This legal loophole has led to a variety of FRM, each treating the problem from a different perspective (soil, water, environment, etc.) (Olcina, 2010a). This situation is very similar to other countries like Austria (Holub and Fuchs, 2009), where the lack of a national law has originated important differences between regions (Thaler et al., 2016).

Conversely, other countries have developed a more responsible natural hazard management. For example, in France the Prevention of Predictable Natural Hazards Plan regulatory embeds the imposition of land use zoning and control measures in SP documents (Erdlenbruch et al., 2009). In the USA, the Federal Disaster Mitigation Act requires states to integrate hazard mitigation activities in land use planning or preparing standalone mitigation plans (Berke et al., 2012). Also, in the UK the Planning Policy Statements responsible of Flood Risk and Development considers flooding as mandatory in spatial planning (Pardoe et al., 2011).

As regard preventive measures against the risk of flooding considered in Spain within SP, we can distinguish three periods: 1956–1998; 1998–2008; and 2008-future. The first period is characterized by an almost total lack of consideration of natural hazards in the law (Olcina, 2010b). The second one started with the land market liberalisation introduced by Land Law of 2008 and which resulted in the well known Spanish "housing boom". This was the first time that natural hazards were considered in planning instruments, but by means of sectoral laws that failed to minimize the effects of floods (Pérez et al., 2015a). In the last period, the municipal plans adapted to the 2008 Land Law, where more restrictive construction measures concerning floods were established. However, as we mentioned above, the effect was not that expected, because the FRM adopted (mainly structural measures) have serious shortcomings and had not prevented the occupation of flood-prone areas, especially in the coastal municipalities of south-eastern Spain (Pérez et al., 2015b).

3. Data and methods

To assess flood hazards and the institutional vulnerability (IV), we intersect by GIS the two sources that define exposure to the risk of flooding: spatial planning and flood extent area (Cardona et al., 2012).

3.1. Spatial planning (SP)

In Spain, the central government can only dictate basic conditions, while the autonomous communities are responsible for the approval of norms for territorial planning and the municipalities for urban development. In this way, municipalities are officially responsible for the process of SP, however each Autonomous Community has its own criteria and denominations for both planning instruments and for categorizing the different municipal areas. According to these denominations, the municipalities classify in different categories all their territory and determine what use is applicable to each area.